Both sides retaliate in the Israeli–Palestinian conflict

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Ending violent international conflicts requires understanding the causal factors that perpetuate them. In the Israeli–Palestinian conflict, Israelis and Palestinians each tend to see themselves as victims, engaging in violence only in response to attacks initiated by a fundamentally and implacably violent foe bent on their destruction. Econometric techniques allow us to empirically test the degree to which violence on each side occurs in response to aggression by the other side. Prior studies using these methods have argued that Israel reacts strongly to attacks by Palestinians, whereas Palestinian violence is random (i.e., not predicted by prior Israeli attacks). Here we replicate prior findings that Israeli killings of Palestinians increase after Palestinian killings of Israelis, but crucially show further that when nonlethal forms of violence are considered, and when a larger dataset is used, Palestinian violence also reveals a pattern of retaliation: (*i*) the firing of Palestinian rockets increases sharply after Israelis kill Palestinians, and (*ii*) the probability (although not the number) of killings of Israelis by Palestinians increases after killings of Palestinians by Israel. These findings suggest that Israeli military actions against Palestinians lead to escalation rather than incapacitation. Further, they refute the view that Palestinians are uncontingently violent, showing instead that a significant proportion of Palestinian violence occurs in response to Israeli behavior. Well-established cognitive biases may lead participants on each side of the conflict to underappreciate the degree to which the other side's violence is retaliatory, and hence to systematically underestimate their own role in perpetuating the conflict.

Over one half of Israelis* and three quarters of Palestinians† think the other side seeks to take over their land. When accounting for their own acts of aggression, Israelis often claim to be merely responding to Palestinian violence (1–3), and Palestinians often see themselves as simply reacting to Israeli violence (4–6). Are these views just self-serving rationalizations designed to justify violence committed for other reasons, or are they in part true? That is, do Israeli attacks against Palestinians in fact occur in response to prior violence by Palestinians, and do Palestinian attacks against Israelis occur in response to prior violence by Israelis? The answers to these questions are important because they carry implications about the nature of the actors on each side, and the most effective strategies for reducing the conflict. Fortunately, these questions can be approached empirically by applying quantitative econometric methods (vector autoregression, VAR) to well-documented empirical databases of the timeline of violence over the Second Intifada.

Several recent studies have taken this approach (7–10) and argued that Israeli killings of Palestinians fit the pattern of retaliation, increasing immediately after Palestinian killings of Israelis, whereas Palestinian killings of Israelis do not fit the pattern of retaliation (8, 10). This finding supports the narrative that Israel merely responds to Palestinian violence, whereas Palestinian attacks are not contingent on Israeli behavior, instead reflecting a fundamental and nonnegotiable goal of harming Israel. This view in turn bolsters Israeli arguments for military over diplomatic solutions on the grounds that "there is no one to talk to." However, the prior analyses suffer from limitations, which make their conclusions premature.

Most importantly, prior analyses consider only killings, not other forms of violence. Three problems arise as a result. First, multiple nonlethal forms of aggression occur on both sides, such as unsuccessful attacks on Israelis by Palestinians, and house demolitions, imprisonment, blockades, and restrictions of movement by Israel against Palestinians. Any of these nonlethal forms of aggression could either cause or constitute retaliation. Second, vector autoregression asks whether killings of one side follow killings by the other side at a consistent time lag. However, given the lower level of organization and technology of the various armed Palestinian factions, such time-locked responses may be difficult for Palestinians to achieve; Jaeger and Paserman (8) suggest, alternatively, that Palestinians may intentionally randomize the timing of their attacks to preclude preventative measures being taken by Israel, which would render any retaliatory attacks invisible to VAR (see refs. 11–13 for a discussion of whether Palestinian groups act rationally). Third, some crucial factors may be invisible to vector autoregression because they are not punctate events but chronic conditions (e.g., chronic fear of suicide bombing and/or rocket attacks among Israelis, and the chronic oppression of living under occupation among Palestinians).

These problems illustrate the impossibility of modeling and testing all potential nonlethal causes and forms of retaliation in the Israeli–Palestinian conflict. However, one form of violence avoids all three problems and is therefore amenable to econometric testing: the firing of Qassam rockets from Gaza into Israel. Rocket firings are punctate events that can be precisely timed; they are rarely lethal [between January 2001 and April 2008, the Israeli Defense Forces (IDF) and B'Tselem registered 3,645 Qassam rocket firings, but only 15 associated fatalities]; and precise quantitative data on the numbers of rockets fired every day are available. Together, this means that if rockets are used in a retaliatory fashion this might be evident in a VAR. We therefore conducted analyses of data that give the number of daily Qassam rockets fired by Palestinians into Israeli territory, irrespective of whether anyone died as a result, and of killings of Israelis and Palestinians by the respective other side. Our analysis covers the period of January 2001 to 2008 (i.e., from the beginning of the Second Intifada until the ceasefire that preceded the December 2008 Gaza war).

We find that Palestinian Qassam rocket firings increase sharply on the day following the killing of Palestinians by Israel. In addition, we show that the probability of Palestinian killings of Israelis (although not the number of people killed) increases following the killing of Palestinians by Israel. Thus, it appears that Palestinian violence does contain an element of retaliation, and that Israeli military operations against Palestinians lead to escalation rather than incapacitation. Consistent with previous analyses, we confirm that Israeli aggression, too, contains an element of retaliation, in that Israel is more likely to kill Palestinians on days following killings of Israelis by Palestinians. Together, these findings suggest that, contrary to previous analyses

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†Palestinian Center for Policy and Survey Research. Survey Research Unit: Public Opinion Poll no. 34. Available at http://www.pcpsr.org/survey/polls/2009/p34e.html.

that characterized Israeli violence alone as retaliatory, the dynamics of retaliation in the Second Intifada are bidirectional.

Results

Summary Statistics. Fig. 1 shows the timeline of violence between Israelis and Palestinians from 2000/2001 to 2008. Each panel is a histogram plotting the daily count of events. Fig. 1*A* shows Palestinian fatalities resulting from Israeli attacks; Fig. 1*B* shows Israeli fatalities resulting from Palestinian attacks; and Fig. 1*C* shows daily counts of Qassam firings by Palestinians into Israeli territory.

Table 1 shows summary statistics associated with these variables. Palestinian fatalities, Israeli fatalities, and Qassam firings occurred on 49.75%, 11.85%, and 34.66% of all days in the dataset, respectively. There were a total of 4,874 Palestinian fatalities, 1,062 Israeli fatalities, and 3,645 Qassam firings; this corresponds to a daily average of 1.65 ± 3.52 (mean ± SD) Palestinian fatalities, 0.36 ± 1.66 Israeli fatalities, and 1.37 ± 3.75 Qassam firings. Of the Qassam firings, 15 (0.41%) resulted in fatalities, underscoring that Qassam firings are a largely nonlethal form of Palestinian aggression.

In the following, we consider two versions of each of the three variables: the number of daily events and the daily incidence. The former variable is the count of events, i.e., the number of Palestinian and Israeli fatalities and Qassam firings on any given day. The incidence is a dummy variable that takes value 1 on days when one or more events occurred, and zero otherwise.

Table 2 shows the pairwise correlation coefficients and their *P* values for the three variables, in terms of number of daily events as well as incidence. It can be seen that Israeli and Palestinian aggression are strongly positively correlated (although Qassam firings and Palestinian fatalities only correlate in levels, not in incidence), whereas the two forms of Palestinian aggression correlate negatively, potentially reflecting a substitution effect. This cursory first analysis suggests that Israeli and Palestinian violence may be mutually related. However, to test for retaliatory aggression, we must consider relationships across time.

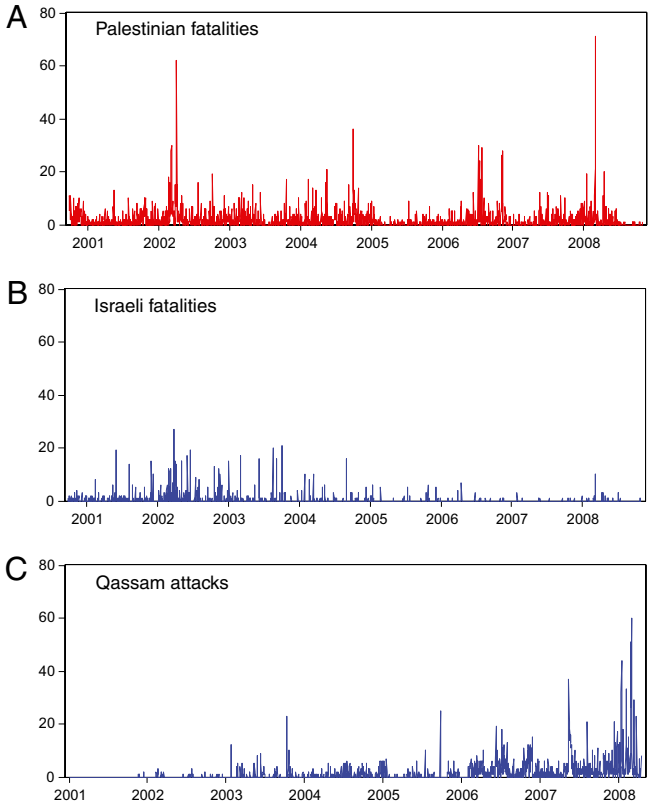

Fig. 1. Time series of Palestinian fatalities (*A*), Israeli fatalities (*B*), and Qassam attacks by Palestinians on Israel (*C*). Data are daily event counts between 2000 and 2008 (Table 1), compiled from data from the Israeli human rights organization B'Tselem (*A* and *B*) and the Israeli Defense Forces (*C*).

Impulse Response Functions. To test for retaliatory patterns of violence, in the restricted sense of temporal relatedness proposed by Granger (14), we initially computed impulse response functions for the three variables (see *Materials and Methods*). As pointed out by Jaeger and Paserman (8), the value of the Israeli response function on day *t* can be interpreted as the excess number of attacks against Palestinians *t* days after a Palestinian attack against Israelis, normalized by the number of attacks against Israelis. The Palestinian response function is interpreted analogously.

Figs. 2 and 3 show the response functions for levels and incidence, respectively. In each panel, an attack of one party occurs at time 0, and the function plots the excess number (Fig. 2) or probability (Fig. 3) of attacks by the other side occurring on the following days.

Our main question was whether Israeli and Palestinian violence show retaliatory patterns. Specifically, we hypothesized that Qassam rocket firings might to some extent be a consequence of previous Israeli aggression against Palestinians. Fig. 2*D* suggests that this may be the case: the number of Qassam rocket firings by Palestinians increases compared with baseline on the days following Israeli killings of Palestinians. Interestingly, Israel does not appear to respond to firings of Qassam rockets (Figs. 2*C* and 3*C*). Conversely, Figs. 2*A* and 3*A* suggest that, as reported previously (8), Israeli killings of Palestinians increase on the days following killings of Israelis by Palestinians. In contrast to previous findings, however, Palestinians appear to not only respond to Israeli attacks with Qassam rockets, but also by increasing the incidence of killings of Israelis (Fig. 3*B*).

Statistical Model. To quantify these findings, we used a standard VAR in which current Israeli and Palestinian fatalities are regressed on lagged values of both variables (see *Materials and Methods* and Tables S1–S3 for details about model choice). We perform these regressions twice for each pair of variables: once for levels and once for the dummy incidence variables. The results of these regressions for the three variables under consideration are shown in Tables S4–S7.

To test based on these regressions whether Israeli attacks predict Palestinian attacks and vice versa, we computed the *F* statistics for the joint significance of the lagged coefficients of the respective other variable. The results are shown in Table 3, and confirm the patterns observed in Figs. 2 and 3: past Palestinian fatalities significantly predict an increase in firings of Qassam rockets, both in terms of the number of rockets fired and the number of days on which firings occur. Thus, the firing of Qassam rockets appears to occur at least partly in response to previous Israeli attacks on Palestinians. (Note that this analysis also shows that the small increase in the incidence of Qassam firings following killings of Palestinians shown in Fig. 3*D* is statistically significant when controlling for the history of attacks.)

In addition, in contrast to the results of Jaeger and Paserman (8), we find that past Palestinian fatalities also predict an increase in the probability that Palestinians will kill any Israelis in the following days (incidence). Conversely, we find that killings of Palestinians by Israelis also contain a retaliatory element, both in terms of levels and incidence; however, this retaliation occurs only after killings of Israelis, and not after (mostly nonlethal) Qassam firings.

To understand the magnitude of these effects, we estimated the percentage of attacks that can be ascribed to retaliation. Our findings suggest that the number of Qassams fired increases by 6% on the first day after a single killing of a Palestinian by Israel; the probability of any Qassams being fired increases by 11%; and the probability of any Israelis being killed by Palestinians increases by 10% (for details, see *Materials and Methods*). Conversely, 1 day after the killing of a single Israeli by Palestinians, the number of Palestinians killed by Israel increases by 9%, and the probability of any Palestinians being killed increases by 20%.

We can then use these values to estimate what proportion of aggression on either side can be attributed to prior attacks from the other side throughout the period under consideration. This calculation (*Materials and Methods*) showed that retaliation accounts for a larger fraction of Palestinian compared with

Table 1. Summary statistics for Palestinian fatalities, Israeli fatalities, and Qassam attacks by Palestinians on Israel

	(1) Palestinian fatalities (September 29, 2000–October 29, 2008)	(2) Israeli fatalities (September 29, 2000–October 29, 2008)	(3) Qassam attacks (January 1, 2001–April 16, 2008)
Days in dataset	2,953	2,953	2,663
No. of days with events	1,469	350	923
Percentage of days with events	49.75%	11.85%	34.66%
Total no. of events	4,874	1,062	3,645
Total no. of fatalities	4,874	1,062	15
Percentage of fatal events	100%	100%	0.41%
Minimum events per day	0	0	0
Maximum events per day	71 (March 1, 2008)	27 (March 27, 2002)	60 (March 1, 2008)
Mean events per day	1.65	0.36	1.37
SD	3.52	1.66	3.75

Data were obtained from the Israeli Human Rights B'Tselem (columns 1 and 2) and the Israeli Defense Forces (column 3).

Israeli aggression: in the levels specification, 10% of all Qassam rockets (358 in number) can be attributed to prior Israeli attacks on Palestinians, but only 4% of killings of Palestinians by Israel (158 in number) can be attributed to prior Palestinian attacks on Israel. In the incidence specification, 6% of all days on which Palestinians attack Israel with rockets, and 5% of all days on which they attack by killing Israelis, can be attributed to retaliation; in contrast, this is true for only 2% of all days on which Israel kills Palestinians.

To solidify these findings, we conducted several controls. First, to ascertain that the increase of Qassam attacks following Palestinian fatalities is not due to Palestinian fatalities on the same day (which might have occurred after the Qassam attacks on that day), we added a control variable for same-day Palestinian fatalities (Table 3); this does not alter the results. Second, we wished to control for the elevated level of Qassam attacks on day 0, i.e., concurrent with Palestinian fatalities. Qassam attacks on the following day(s) might be the result of previous Israeli aggression, which, however, might in turn be triggered by these Qassam attacks on day 0. We address this potential confound in two ways. First, the VAR analysis controls for previous own aggression; thus, Qassam attacks are higher following Palestinian fatalities, holding constant previous Qassam attacks. Second, as can be seen from the regression tables (Tables S4–S7), the increase of Qassam rockets after Palestinian fatalities was most significant on the first day after such fatalities. We therefore repeated the analysis without taking into consideration attacks that occurred on days after mutual Israeli and Palestinian attacks. The results are shown in Table 3; again it can be seen that Palestinian fatalities predict an increase in Qassam attacks, but not vice versa, although the effect reaches significance only in the incidence specification.

Discussion

In this study, we replicate prior findings that Israeli killings of Palestinians fit the pattern of retaliation—that is, they increase after Palestinian killings of Israelis (8, 10; see also refs. 15–18). However, unlike prior studies, we show that Palestinian violence also shows a retaliatory pattern: (*i*) the firing of Qassam rockets increases sharply after Israelis kill Palestinians, and (*ii*) the probability (although not the number) of killings of Israelis by Palestinians increases after killings of Palestinians by Israel. This finding argues against the narrative that sees Palestinians as inherently and unconditionally violent. Instead, our analysis shows that Palestinian violence is in part contingent on Israeli violence: Palestinians, like Israelis, are more likely to attack after they themselves have been attacked. In addition, it shows that Israeli military actions against Palestinians may lead to escalation of violence rather than incapacitation of Palestinian military operations against Israel.

Table 2. Correlation coefficients for Palestinian and Israeli fatalities and Qassam firings, and their associated *P* values

Variable pair		Levels	Incidence
Palestinian × Israeli fatalities	Coefficient	**0.1092**	**0.1449**
	P value	**0.0000**	**0.0000**
Palestinian fatalities × Qassam attacks	Coefficient	**0.2708**	0.0286
	P value	**0.0000**	0.1399
Qassam attacks × Israeli fatalities	Coefficient	**−0.0405**	**−0.0913**
	P value	**0.0367**	**0.0000**

Significant correlations are set in bold.

Is the Israeli–Palestinian conflict a "cycle of violence" in which each attack is followed by a counterattack in a tit-for-tat fashion? Jaeger and Paserman (8) argue that it is not, because their analyses found that Israeli violence fit a pattern of retaliation, whereas Palestinian violence did not (9, 19–21). In contrast, our data show that both sides retaliate, consistent with tit-for-tat dynamics. One might argue that the firing of rockets does not constitute the continuation of a cycle, because rocket attacks rarely lead to Israeli fatalities. Indeed, our data show that rocket attacks are usually not followed by retaliation by Israel. Nonetheless, rocket attacks cause widespread public anger in Israel and attract broad media coverage. Thus, even though rocket attacks are usually not met with an immediate, time-locked increase in killings of Palestinians, they may nonetheless lead to an overall (not time-locked) increase in Israeli violence against Palestinians, thus continuing the cycle in the longer run. In addition, we find that Palestinian retaliation also occurs through an increased probability of killings of Israelis; this Palestinian response is unambiguously a continuation of the cycle of violence, both in terms of public attention and Israeli military reaction. Thus our data show that, in contrast to prior reports, some aspects of the Israeli–Palestinian conflict fit the tit-for-tat cycle of violence pattern (15, 22–24).

Our findings may be most newsworthy to the participants in this conflict themselves. Palestinians and Israelis each tend to describe themselves as victims in the conflict; each side describes their own violent attacks as retaliatory; and each describes the attacks of the other side as caused by aggressive intent rather than as responses to external attack. Of course, public statements from each side are bound to reflect self-serving efforts to gain the moral high ground in the battle of public opinion. However, deeper cognitive forces may also be at play (25). It is well documented in the psychology literature that people tend to see their own behavior as driven more by the situation they are in (e.g., being under attack by the other), but see the behavior of others as driven more by their disposition (e.g., being inherently hostile or violent) (26). These fundamental cognitive biases may lead each side to underappreciate the degree to which the other side's violence is retaliatory, and therefore to systematically underestimate their own role in perpetuating the conflict (27).

Despite the symmetrical pattern of violence we report here, in which both sides retaliate for attacks from the other side, other aspects of the Israeli–Palestinian conflict are characterized by deep asymmetries. Most obviously, over 4× as many Palestinians

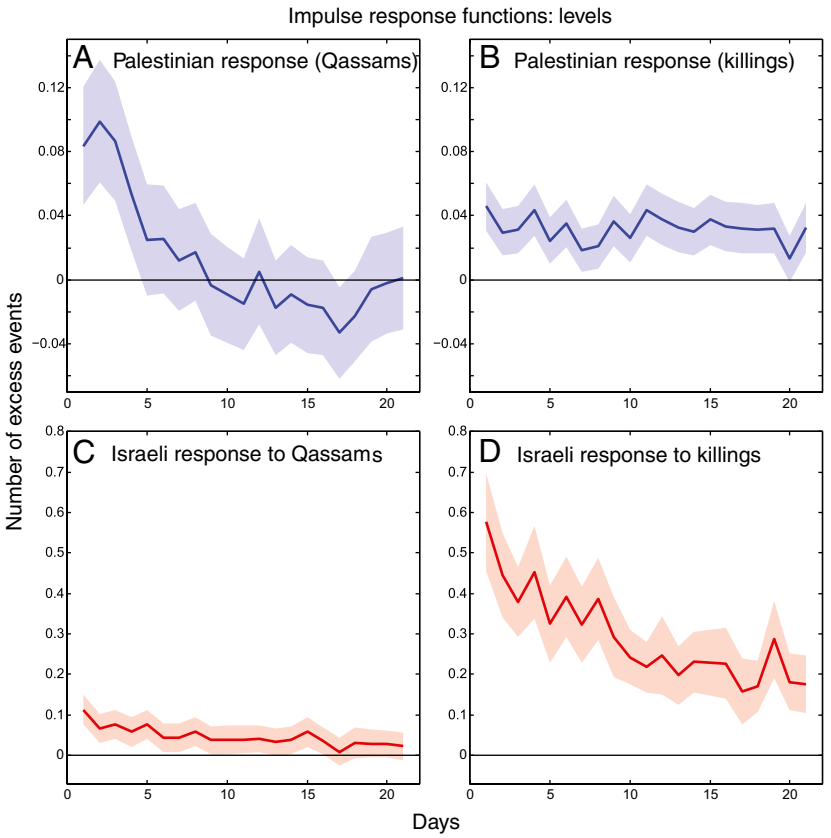

Fig. 2. Impulse response functions for number of events (levels). Each graph shows the excess number of attacks by one side following an attack from the respective other side. (*A*) Palestinian response in terms of Qassam rocket attacks to killings of Palestinians by Israel. (*B*) Palestinian response in terms of killings of Israelis to killings of Palestinians by Israel. (*C*) Israeli response in terms of killings of Palestinians to Qassam attacks by Palestinians. (*D*) Israeli response in terms of killings of Palestinians to killings of Israelis by Palestinians.

as Israelis were killed in the period investigated here; during the subsequent 2008–2009 Gaza war (after the period studied here) this asymmetry reached about 100 Palestinian deaths for each Israeli death. Second, Israel controls and often severely restricts many facets of Palestinian life, including access to food and medicine and freedom to move within and outside their territory, whereas Palestinians exert no such control over Israelis. Third, in an asymmetry particularly important for the present study, the IDF is one of the most technologically sophisticated and well-trained military organizations in the world, whereas the Palestinians have no regular military at all, only an array of armed factions not under direct central governmental control. Indeed, this lack of central control and less-sophisticated technology on the Palestinian side likely explains why prior VAR analyses focusing on only killings did not detect the time-locked pattern of Palestinian retaliation that we found in rocket firings.

Given that Qassam attacks are almost completely ineffective in killing Israelis, one might ask why Palestinians engage in firing these rockets. Several potential answers present themselves. One intuitive reason is that Palestinians use all means available to them to respond to Israeli attacks; the military power of Palestinians is vastly inferior to that of Israel, and Palestinians do not have access to many means other than rockets. (Of course, we do not claim that Palestinian retaliation occurs only through rockets or the probability of Israeli fatalities; other forms of Palestinian retaliation may well exist, but data on it may be more difficult to obtain.) In addition, there is some evidence that Israel increases its vigilance (e.g., by closing borders) after it has killed Palestinians (8). This fact might make it even more difficult for Palestinians to retaliate, leading them to resort to rockets as the only viable form of retaliation (28–30). Second, though Qassams are not particularly effective at killing Israelis, they do cause significant psychological distress among Israelis (though not incurring a military response from Israel in the period under investigation, discussed below), which is mirrored in the strong political and public response to the rocket attacks in Israel (3, 7). A related possibility is that rocket attacks are used by Palestinian factions (particular extremist ones) to solidify their position and reputation among the Palestinian population (31–33, 9). Finally, attacks may be used to affect political opinion in Israel (34–36), cause economic damage to Israel (37, 38), or, more generally, to derail the peace process (12, 39).

Conversely, another question that emerges from these findings is why Israel responds so strongly to killings of Israelis but does not show a time-locked response in terms of Palestinian fatalities to Qassam rockets over the period under consideration. One possible explanation is that the IDF recognize that only a relatively small proportion of rocket attacks result in fatalities; this fact may reduce the IDF's motives to retaliate against Qassams militarily. Alternatively, one might conjecture that Israel responds to Qassam firings with less-than-lethal violence against Palestinians; we do not have data available that would speak to this question, but future analyses might ask whether Israel responds to Qassam firings by, e.g., imposing restrictions on freedom of movement on Palestinians.

An important caveat of the present study is that our analyses cannot test causation directly; rather, they test whether the timeline of events fits the temporal profile expected for retaliation, i.e., whether one event reliably predicts the other event at a later time (14). Nonetheless, the most straightforward interpretation of our findings is that it is not only Israelis who retaliate for killings of Israelis by killing Palestinians, but also Palestinians who retaliate for killings of Palestinians by firing rockets and by increasing the probability of killing Israelis on any given day.

A related potential concern regarding our findings is reverse causation. Our data could, for instance, reflect killings of Palestinians by Israel in anticipation of rocket attacks, rather than Palestinian retaliation for previous killings of Palestinians by Israel. Three facts argue against this possibility. First, one would expect that if Israel kills Palestinians in anticipation of rocket attacks, these actions would lead to a decrease in rocket attacks following killings of Palestinians by Israel, rather than the increase that is actually observed. Second, if prevention of attacks was the main reason for Israeli attacks, one would expect Israeli killings of Palestinians to occur not only before but also after rocket attacks; in fact, one might argue that killings of Palestinians by Israel

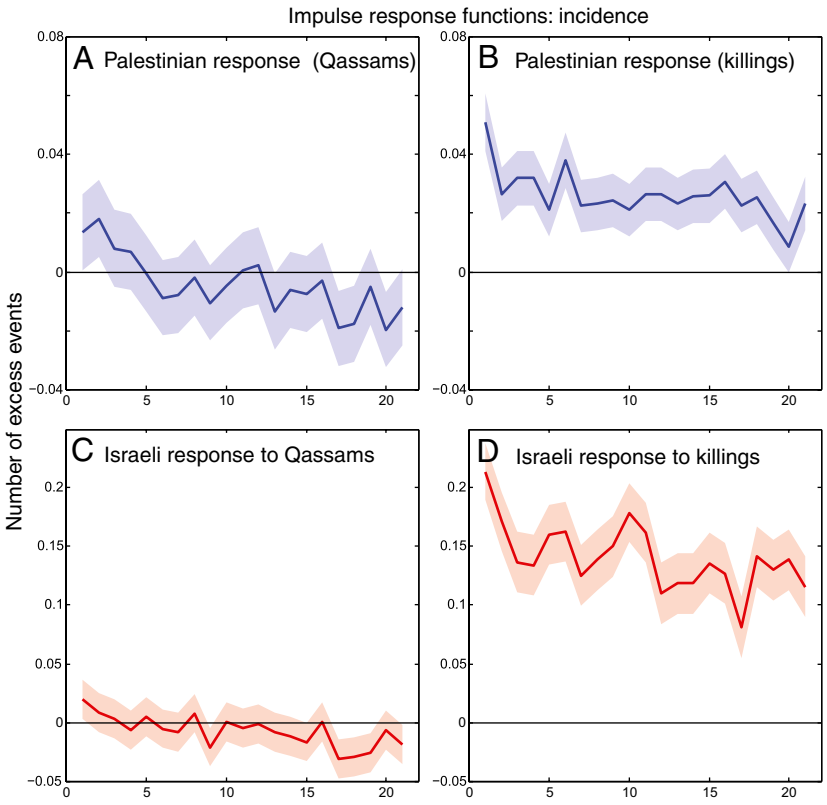

Fig. 3. Impulse response functions for probability of events (incidence). Each graph shows the excess probability of attacks by one side following an attack from the respective other side. (*A*) Palestinian response in terms of Qassam rocket attacks to killings of Palestinians by Israel. (*B*) Palestinian response in terms of killings of Israelis to killings of Palestinians by Israel. (*C*) Israeli response in terms of killings of Palestinians to Qassam attacks by Palestinians. (*D*) Israeli response in terms of killings of Palestinians to killings of Israelis by Palestinians.

should increase strongly following rocket attacks, reflecting Israeli operations to shut down the cells that were responsible for the attacks. However, we find that killings of Palestinians by Israel do not in fact increase significantly following rocket attacks. This result suggests that the killings of Palestinians by Israel preceding rocket attacks are usually not preventative measures to suppress rocket attacks. Finally, the preceding argument is strengthened by the IDF rules of engagement surrounding Palestinian rocket attacks: according to Harel (3), "soldiers are allowed to fire freely at rocket- and mortar-launching cells immediately before, during or after a launch, and with permission from a senior officer, they can also fire at Palestinians trying to lay bombs within half a kilometer of the border fence. Other than that, however, no offensive operations are permitted." In other words, it is likely that preventative attacks by Israel would be concentrated on the day of the (attempted) rocket attacks, rather than occurring mainly on the day prior. Because the data show that Israeli attacks in fact do occur on the day preceding rocket attacks, we conclude that the rocket attacks are a consequence, rather than a cause, of the Israeli attacks. These arguments hold analogously for the increased probability of killings of Israelis by Palestinians following Israeli attacks on Palestinians. Conversely, the argument against reverse causality in the context of the Israeli response to Palestinian attacks has been made elsewhere (8, 10).

In sum, our analyses of the temporal dynamics of violence in the Second Intifada show evidence both of Israeli retaliation for Palestinian violence and Palestinian retaliation for Israeli violence. These findings suggest that the Israeli–Palestinian conflict is characterized by retaliatory dynamics in both directions: both sides respond to killings by the other side in a time-locked fashion; in the case of Israel, this response takes the form of killings of Palestinians, whereas in the case of the Palestinians, it

Table 3. Israeli and Palestinian relaliation for killings and Qassam attacks

Specification	Test statistic	(1) Palestinian retaliation using Qassams		(2) Palestinian retaliation using killings		(3) Israeli retaliation for Qassams		(4) Israeli retaliation for killings	
		Levels	Incidence	Levels	Incidence	Levels	Incidence	Levels	Incidence
Basic	*F*	**3.0733**	**2.3693**	1.7486	**8.8439**	1.0363	1.1364	**2.9971**	**10.3071**
	P	**0.0090**	**0.0372**	0.1201	**0.0000**	0.4139	0.2982	**0.0176**	**0.0000**
Control same-day events	*F*	**3.5771**	**2.2527**	0.8238	**5.4941**	**1.6899**	1.2655	**2.7133**	**7.5588**
	P	**0.0032**	**0.0467**	0.5325	**0.0000**	**0.0233**	0.1824	**0.0285**	**0.0000**
Omit mutual events at t-1	*F*	1.4334	**2.4531**	0.5007	**7.6371**	1.2465	1.2170	**2.1231**	**5.5271**
	P	0.2090	**0.0317**	0.7759	**0.0000**	0.1973	0.2216	**0.0754**	**0.0002**
Control variable for years	*F*	**3.125**	**3.824**	1.1177	**3.4432**	0.9271	2.0559	**2.8322**	**4.5972**
	P	**0.0081**	**0.0019**	0.3486	**0.0042**	0.5584	0.0026	**0.0233**	**0.0011**

Table reports the test statistics for the test of the null hypothesis that the lagged coefficients on the respective other variable are jointly equal to zero. Significant statistics are set in bold and can be interpreted as retaliation by one party for previous violence from the other side. Columns 1 and 2 report Palestinian retaliation after killings of Palestinians by Israel, i.e., killings of Israelis by Palestinians (column 1), or Quassam attacks by Palestinians on Israel. Columns 3 and 4 report Israeli retaliation, i.e., killings of Palestinians by Israel, following either Qassam attacks by Palestinians on Israel (column 3) or killings of Israelis by Palestinians (column 4).

comes in the form of (mostly nonlethal) Qassam attacks against Israel. In addition, Palestinians appear to retaliate by increasing the probability of killing Israelis on any given day. The implication of our findings is that both sides are at least to some extent correct when they claim that their aggression occurs in response to previous aggression from the respective other party. To the extent that both sides see themselves in a purely retaliatory role, our data suggest that in doing so they may underappreciate the extent to which the violence of the other side is contingent on their own. An increased awareness of this bias may lead both sides to better understand their own role in perpetuating the conflict, and thus contribute to its resolution (27).

Materials and Methods

Daily counts of Israeli and Palestinian fatalities were obtained from B'Tselem (www.btselem.org/); daily counts of Qassam attacks were obtained from the IDF.

Following Jaeger and Paserman (8), we defined the Israeli response function as

$$IsrRF_t = \left(\frac{\sum_{s:I_s>0} I_s}{\sum_{s:I_s>0} 1}\right)^{-1} \left(\frac{\sum_{s:I_s>0} P_s}{\sum_{s:I_s>0} 1} - \frac{\sum_s P_s}{T}\right)$$

and the Palestinian response function as

$$PalRF_t = \left(\frac{\sum_{s:P_s>0} P_s}{\sum_{s:P_s>0} 1}\right)^{-1} \left(\frac{\sum_{s:P_{s-t}>0} P_s}{\sum_{s:P_{s-t}>0} 1} - \frac{\sum_s I_s}{T}\right).$$

Here, I_s and P_s denote the number of attacks against Israelis and Palestinians on day s, respectively; attacks against Israelis can be either Israeli fatalities or Qassam firings.

To prepare the VAR, we first used Schwarz's Bayesian information criterion to choose the most appropriate autoregressive order for each of the three variables; the optimal number of lags was 5 for Palestinian fatalities, 4 for Israeli fatalities, and 22 for Qassam rocket firings (Table S1). We then ascertained that the time series were stationary using an augmented Dickey–Fuller test (Table S2). Next we considered two alternative VAR models—namely, OLS and negative binomial (NB) models. Leave-one-out cross-validation showed that OLS made better out-of-sample predictions than NB; we therefore based our analyses on OLS (Table S3).

Thus, we fit the following system of equations:

$$I_t = \alpha_I + \sum_{s=1}^{L_I} \beta_{I,s} I_{t-s} + \sum_{r=1}^{L_P} \gamma_{I,r} P_{t-r} + \varepsilon_{I,t}$$

$$P_t = \alpha_P + \sum_{r=1}^{L_P} \beta_{P,r} P_{t-r} + \sum_{s=1}^{L_I} \gamma_{P,s} I_{t-s} + \varepsilon_{P,t}$$

Here, I_t and P_t again denote attacks against Israelis and Palestinians on day t, respectively; L_I and L_P is the optimal number of lags on attacks against Israelis and Palestinians, respectively, determined by information criteria; $\alpha_{I,t}$ and $\alpha_{P,t}$ are the constant terms; and $\varepsilon_{I,t}$ and $\varepsilon_{P,t}$ the error terms.

To test whether past attacks on Palestinians predict current attacks against Israelis, we asked whether the L_I elements of the coefficient vector γ_I are jointly significantly different from zero by computing their F statistic. Conversely, to test whether past attacks on Israelis predict current attacks against Palestinians, we asked whether the L_P elements of the coefficient vector γ_P are jointly significantly different from zero.

Further details are given in *SI Text*.

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